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The Interconnections Between Services and Goods Trade at the Firm-Level*

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Abstract

In this paper we study how international trade in goods and services interact at the firm level. Using a rich dataset on Belgian firms for the period 1995-2005, we show that: i) firms are much more likely to source services and goods inputs from the same origin country rather than from different ones; ii) joint imports are associated with higher firm productivity; iii) increases in barriers to imports of goods reduce firm-level imports of services from the same market, and conversely. We build upon a discrete-choice model of goods and services input sourcing that can reproduce these facts to guide our econometric strategy. We use our results to quantify the impact of reductions in goods and services barriers between the US and the EU. Our findings have important implications for the design of trade policy. They suggest that a liberalization of services trade can have direct and sizable effects on goods trade, and vice versa. Moreover, liberalizing goods and services trade jointly brings substantial complementarities.

Keywords: Trade in Services; Trade in Goods; Complementarity; Firm-level Analysis; Discrete Choice Models.

JEL Classification: F10, F13, F14, L60, L80.

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1 Introduction

Services feature prominently on the trade liberalization agenda. After the recent Canada-EU Trade Agreement (CETA), the European Commission stated that "around half of the overall GDP gains for the EU will come from liberalising trade in services".[1] The recent Trade in Services Agreement (TiSA) initiative between the US, the EU and 21 trade partners aims to breathe new life into the Doha Round liberalization talks. While the future of a trade agreement between the US and EU is highly uncertain in the current political climate, the proposed Transatlantic Trade and Investment Partnership (TTIP) had services at the heart of its "Market Access" chapter. At the same time a key element in the ongoing Brexit negotiations for the UK, the second largest services exporter in the world, is the future of trade in services with both the EU and the rest of the world.

To date, the economic evaluation of services trade barriers has relied on sector-specific studies (Francois and Hoekman, 2010), general equilibrium work with separate goods and services sectors (Francois et al., 2003; Egger et al., 2012) or services-only gravity models (Anderson et al., 2014). Yet, both anecdotal evidence and recent research show increasingly blurred boundaries between the manufacturing and services sectors. Production and trade statistics reveal significant services sales, exports and imports by manufacturing firms.[2] This may partly reflect a "servitization" process, i.e., a shift from products to solutions and integrated "product-service systems" (Neely, 2008), as well as a greater reliance of manufacturing firms on intermediate services, both domestic and imported (Nordås, 2010; Timmer et al., 2013). These observations raise the possibility that goods trade may benefit from services trade liberalization, and vice versa.

In this paper, we study if and how both types of trade interact at the level of individual firms. In particular, we study how firms' imports of goods respond to the liberalization of trade in services, and how firms' imports of services react to goods trade liberalization. We believe this question is important for at least two reasons. First, simultaneous imports of goods and services are a first-order feature of our data, representing more than 80 per cent of the total value of Belgian imports. Thus, existing firm-level research focused exclusively on, for example, goods trade completely overlooks an important services trade component, and vice versa. Secondly, estimating the interactions between the two forms of trade is directly relevant for the design of trade policy and for ongoing trade negotiations. Indeed, if there are complementarities in

[1] See http://ec.europa.eu/trade/policy/in-focus/ceta/

[2] See Crozet and Milet (2017b), Breinlich and Criscuolo (2011), Ariu and Mion (2018), Walter and Dell'mour (2010) and Kelle and Kleinert (2010) among others.

sourcing goods and services from the same origin, lowering services barriers might lead to higher services *and* goods imports. This also suggests that recent efforts to liberalize trade in services - where trade barriers are still significant - might be highly effective at increasing *goods* trade given that tariff barriers have already fallen to historically low levels.

To explore the interactions between goods and services trade and trade liberalization at the firm level, we start by analyzing highly disaggregated data on Belgian firms' imports between 1995 and 2005. Our descriptive exercise shows three main patterns: i) firms are disproportionately more likely to import goods and services from the same rather than from separate origins; ii) firms sourcing goods and services from the same origin show better performance across a range of productivity measures, both in a cross-section and in a difference-in-difference analysis; iii) reduced-form regressions suggest that, even when controlling for firm-year and country unobservables, a reduction in the goods trade barriers imposed against a country increases the likelihood of observing positive services imports from that same country, and lower services trade barriers make goods imports more likely as well.

We build a model of goods and services input sourcing which can reproduce these stylized facts and offers guidance for our subsequent empirical analysis. The model features a final sector and two (goods and services) intermediate sectors. Final producers may source intermediate goods and services domestically or from abroad. To capture the observed sparsity of imports across origin countries, intermediate sourcing is represented as a discrete choice between pairs of country-specific goods and services varieties. The model fully specifies the probability of sourcing inputs from different countries and shows that this probability increases in input quality and decreases with trade costs, all else equal. Conditional on that choice, goods and services import values are specified as functions of a narrow set of parameters. The model also allows for technological complementarities between inputs coming from the same origin country.

We then use the model to guide our estimation strategy. We use a two-stage econometric approach where the first stage describes the choice of origin countries and the second stage describes the value of imports of goods and services from chosen country pairs. The theoretical model provides us with guidance on how to combine and interpret parameters as well as on how to deal with selection bias in a consistent and parsimonious way. More specifically, we use the selection model developed in Lee (1983) and described by Bourguignon et al. (2007). The first-stage selection equation features a conditional multinomial logit for the probability to source inputs from a given country. In the second stage, we estimate two export value outcome regressions, one for goods and one for services, that are augmented with selection-bias controls coming from the first stage. We also allow for both firm-specific time-varying and country-specific time-invariant unobservables that may be arbitrarily correlated with the regressors in both the first and second stage.

Finally, we use our estimates to perform a quantification exercise. We examine the impact of three policy experiments consisting in reductions in goods and services trade barriers between the EU and the US. We find large trade gains stemming from further integration that, in the current international political climate, might well be best considered as foregone gains from the lack of further integration. In particular, we look at the "elimination" of goods tariffs and services trade barriers between the EU and the US, first separately, then together. In the case of services, we assume that trade barriers between the US and the EU are lowered to a level corresponding to countries having bilateral preferential trade agreements including a services component, as reported by the WTO secretariat. Results reveal substantial gains from liberalizing trade with the US. A joint good-service liberalization would boost Belgian imports from the US by 22% for goods and 11% for services. Assuming the same increase for the whole of the EU would imply an increase in imports of, respectively, 60 and 24 billion dollars. An important element in our results is that the gains from liberalizing both goods and services together are higher than the sum of liberalizing goods and services separately. This demonstrates the presence of strong complementarities between goods and services trade that have the potential of amplifying the impact of changes in trade barriers. We believe that this is an observation that deserves more attention in current trade negotiations.

In addition to the literature on the quantification of services trade barriers mentioned above, our work contributes to a small number of papers studying the connections between services and goods trade and production at the level of individual firms. This literature has been mostly descriptive in nature, highlighting the importance of firms trading in, or producing, both goods and services (e.g. Lodefalk, 2013; Crozet and Milet, 2017b; Ariu, 2016b). Three recent exceptions are Breinlich et al. (2018), Crozet and Milet (2017a) and Ariu et al. (2018). Breinlich et al. (2018) analyze the impact of goods trade liberalization on the shift of UK manufacturing firms into services, but do not look at trade responses nor at the interaction between goods and services imports. Crozet and Milet (2017a) study the interaction between goods and services in the domestic market, finding that service sales have a positive impact on the performance of manufacturing firms. Their paper complements ours with a domestic perspective on the relationship between goods and service production but does not investigate the related policy issues. Ariu et al. (2018) investigate why manufacturing exporters associate services with goods exports and provide micro-foundations for the different mechanisms that can explain the complementarity between goods and services. While complementing our work on the export as opposed to the import side, they do not look at trade policy scenarios.[3]

Our work is also related to recent quantitative models of firm-level imports, such as Kasahara and Lapham (2013), Armenter and Koren (2013) and Antras et al. (2017). While these papers also look at import sourcing at the firm level, they do not incorporate services trade and its interaction with goods trade.

Finally, we follow a growing literature in using the OECD's Product Market Regulation Index (PMR) to capture the degree of policy restrictiveness in a range of service sectors. A number of recent papers have demonstrated that restrictions in upstream service sectors can negatively affect the performance of the downstream manufacturing sectors using those services (see Barone and Cingano (2011); Bourles et al. (2013); Arnold et al. (2016)). Similar to Crozet et al. (2016) we argue here that the PMR is also well suited to capturing import barriers and show how it can be used to explain the sourcing choices of Belgian manufacturing firms.

This paper is organized in five additional sections. Section 2 presents the data and the stylized facts paving the way for the theoretical model. Section 3 offers a model of firm-level importing of goods and services intermediate inputs consistent with these facts. Section 4 introduces our main econometric specification and the corresponding empirical results. In Section 5 we present the quantification exercise. Section 6 concludes.

2 Data and Stylized Facts

In this section we outline the data used in the analysis and provide some descriptive evidence that will guide the construction of the theoretical framework.

2.1 Data

Our empirical analysis uses four types of data: data on trade in services, data on trade in goods[4] as well as service and goods trade barriers.

[3] There is also a more substantial business literature on the shift of manufacturing firms into services provision; see for example Roy et al. (2009) and Neely et al. (2011). These papers are descriptive in nature and do not look at services trade.

[4] The National Bank of Belgium (NBB) trade data used in this paper is confidential and cannot be shared with third parties. Researchers willing to access this data should send a request to Catherine Fuss at the Research Department of the NBB. Please note that in order to replicate the present study the data can be accessed only at the NBB premises and under the supervision of a member of the Research Department. All the necessary files to construct the dataset and perform the replication exercise will be provided upon request.

Trade Data. Information on goods imports comes from the National Bank of Belgium (NBB). The data is organized at the firm-year-origin-product level and spans the 1995-2005 period. Firms are identified by their VAT number and goods are classified using the CN 8-digit nomenclature. We consider only transactions giving rise to a change in ownership and we get rid of transactions referring to movements of stocks, replacement or repair of goods, processing of goods as well as returns and transactions without compensation. In this way, we eliminate trade performed by non-resident firms, accounting for the majority of re-exports. The requirement for observing a firm-level flow is rather low: firms trading with EU countries had to declare their transactions in a given year if their cumulative imports in the European Union were above 104,115 Euros the year before. This threshold increased to 250,000 Euros between 1998 and 2005. Firms trading with extra-EU countries had to declare to the NBB any transaction exceeding 1,000 Euros and this limit remained stable over the 1995-2005 period.[5] Similar thresholds apply to the French data used in Eaton et al. (2011), Mayer and Ottaviano (2007) and Mayer et al. (2014).

Data on service imports were collected by the NBB during the period 1995-2005 to compile the Balance of Payments. In particular, a list of firms had to directly declare to the NBB any service transaction with a foreign firm above 12,500 Euros (9,000 Euros from 1995 to 2001). For the other firms, the bank involved in the service transaction was obliged (under the same threshold requirements) to record the information and send it to the NBB.[6] The data is organized at the firm-year-origin-product level. Firms are identified by their VAT number and the service product classification follows the usual Balance of Payments codes counting 39 types of service products.[7] We do not consider transactions classified as *"Merchanting"* and *"Services between Related Enterprises"*. We exclude the first category because it combines the value of merchanting services and the value of the goods involved. We exclude the second because it doesn't provide information on the specific service product traded. The data comprises transactions under modes one, two and four of trade in services as defined by the General Agreement on Trade in Services (GATS), but there is no information on the specific mode used in each transaction.[8]

We match the datasets on trade in goods and services by means of the unique

[5] For more details on this dataset see Amiti et al. (2014), Ariu (2016b), Bernard et al. (2010) and Muûls and Pisu (2009).

[6] After 2005 the information on trade in services was collected using different surveys targeting different types of services and firms. This major change prevents us from extending the analysis to more recent years. For more details about the change in the collection system we refer to Ariu (2016a).

[7] See Table 1 in Ariu (2016b) for a complete list.

[8] The logic of our model can be extended to mode 3 exports with appropriately defined variable trade costs. However we choose to exclude these transactions from the analysis due to coverage and quality issues with affiliate sales (FATS) data.

VAT firm identifier. As will become clear in the following, our estimation procedure is computationally intensive, forcing us to reduce the dimensionality of our data in three ways. First, we focus on the top 50 origin countries in terms of total Belgian imports (goods and services) over the 1995-2005 period. Such countries represent 97.2% of total Belgian imports over the period of analysis and are listed in Table 2 in the online appendix.

We further restrict the analysis to those firms that have imported both goods *and* services at least once during the period 1995-2005, though not necessarily from the same country or in the same year. Apart from computational considerations, this last restriction is applied because our objective is to study interconnections between goods and services imports at the firm level. In order to construct firm-specific measures of trade barriers (see below), we also need at least one import flow for both goods and services. This second restriction means that we cannot make predictions about the counterfactual behavior of firms outside our sample, such as non-importers turning into importers. However, we can account for counterfactual scenarios in which, for example, firms re-start importing services, or start importing from other origin countries. Overall, firms in our sample accounted for 83.4% (84.4%) of Belgian imports of goods (services) from the selected 50 countries in 2005.

In order to gain insights into what goods and services are imported jointly, Tables 1 and 2 break down goods and services imports by product category among all importers (A), the sample used in the estimation (ES) and the sub-sample of firms with joint imports of goods and services from the same origin country and year (Strict Joint imports: SJ). Sample SJ represents 43.42% (49.43%) of the value of goods (services) imports in the ES sample. Column 2 of Table 1 reveals that the most common imported products are Machinery, Vehicles, Mineral Products, and Chemicals. Columns 3 and 4 show similar product breakdowns in sample ES and (to a lesser extent) SJ, suggesting that joint goods-services imports affect most product categories. Columns 5 and 6 indicate that joint sourcing is more likely in some categories though, namely Mineral Products, Chemicals and Vehicles. Similarly, Table 2 reveals that Transportation, Travel and Other business services represent the main services imported, but only the latter are likely to be imported jointly with goods, as are IT, Communication and Construction services. Overall, the same products tend to be imported jointly in samples ES and SJ and the joint sourcing phenomenon is not driven by transportation or travel services.

Finally, we drop the product dimension and work with aggregate goods and services imports at the firm-destination level to make our empirical analysis computationally feasible. Thus, for each firm-origin country-year combination, we observe *total* goods and *total* services imports. We will, however, use the product dimension in the con-

Table 1: Breakdown of Belgian goods imports by products.

Section	Share of imports (A)	Share of imports (ES)	Share of imports (SJ)	Ratio 1 (ES/A)	Ratio 2 (SJ/A)
LIVE ANIMALS; ANIMAL PRODUCTS	2.81%	2.50%	2.02%	0.8927	0.7185
VEGETABLE PRODUCTS	3.06%	2.82%	1.81%	0.9225	0.5909
ANIMAL OR VEGETABLE FATS AND OILS AND	0.57%	0.62%	0.50%	1.0828	0.8728
PREPARED FOODSTUFFS; BEVERAGES	4.53%	4.29%	3.46%	0.9459	0.7633
MINERAL PRODUCTS	10.83%	12.33%	20.82%	1.1384	1.9214
PRODUCTS OF THE CHEMICAL OR ALLIED	10.98%	11.64%	14.65%	1.0599	1.3342
PLASTICS AND ARTICLES THEREOF; RUBBER	6.05%	5.61%	5.42%	0.9280	0.8958
RAW HIDES AND SKINS	0.43%	0.33%	0.17%	0.7637	0.3857
WOOD AND ARTICLES OF WOOD; WOOD	1.08%	0.74%	0.54%	0.6847	0.4989
PULP OF WOOD OR OF OTHER FIBROUS	3.01%	2.82%	2.41%	0.9375	0.7998
TEXTILES AND TEXTILE ARTICLES	4.85%	3.81%	2.65%	0.7853	0.5449
FOOTWEAR	0.62%	0.42%	0.13%	0.6756	0.2062
ARTICLES OF STONE	1.40%	1.18%	0.98%	0.8473	0.7056
NATURAL OR CULTURED PEARLS	7.16%	8.00%	2.53%	1.1176	0.3542
BASE METALS AND ARTICLES OF BASE METAL	7.46%	7.26%	7.60%	0.9737	1.0184
MACHINERY AND MECHANICAL APPLIANCES;	18.16%	18.26%	17.09%	1.0056	0.9410
VEHICLES	11.78%	12.83%	14.00%	1.0893	1.1892
OPTICAL INSTRUMENTS	1.98%	1.90%	1.46%	0.9571	0.7349
ARMS AND AMMUNITION; PARTS AND	0.05%	0.05%	0.05%	0.9683	1.0414
MISCELLANEOUS MANUFACTURED ARTICLES	2.45%	1.77%	0.83%	0.7226	0.3399
WORKS OF ART	0.74%	0.81%	0.90%	1.0931	1.2065

Note: product shares are computed for the 1995-2005 imports of all Belgian firms (A), firms in our estimation sample (ES) and firms importing goods and services from the same country in the same year (Strictly Joint imports or SJ).

Table 2: Breakdown of Belgian services imports by product.

Section	Share of imports (A)	Share of imports (ES)	Share of imports (SJ)	Ratio 1 (ES/A)	Ratio 2 (SJ/A)
Transportation	31.81%	29.69%	22.59%	0.9333	0.7101
Travel	20.56%	21.26%	15.05%	1.0338	0.7317
Communications services	4.03%	4.46%	6.28%	1.1076	1.5592
Construction services	3.08%	3.10%	4.51%	1.0081	1.4669
Insurance services	1.98%	1.41%	0.34%	0.7092	0.1696
Financial services	4.65%	4.65%	4.55%	1.0006	0.9798
Computer and information services	5.29%	5.71%	7.63%	1.0793	1.4407
Royalties and license fees	4.26%	4.64%	7.54%	1.0896	1.7705
Other business services	21.43%	22.09%	28.28%	1.0313	1.3201
Personal, cultural, and recreational services	1.48%	1.43%	1.40%	0.9618	0.9454
Government services, n.i.e.	1.43%	1.56%	1.84%	1.0894	1.2798

Note: product shares are computed for the 1995-2005 imports of all Belgian firms (A), firms in our estimation sample (ES) and firms importing goods and services from the same country in the same year (Strictly Joint imports or SJ).

struction of our trade barrier measures below. This choice also means that we do not have to address the issue that the levels of aggregation for goods and services are very different (39 service types compared to about 10,000 products).

Trade Barriers Data Turning to trade barriers data, we use data on ad valorem applied goods import tariffs coming from the online customs tariff database (TARIC) provided by the European Commission. This dataset combines most-favored nation and preferential tariff-like restrictions applying to goods entering the EU market by country of origin and CN8 product code for several years. This level of detail is a unique feature of these data compared to, for example, the widely used UNCTAD's TRAINS database in which only information at the HS6 digit is available.[9] The data is organized at the country of origin-product level and is available for the entire 1995-2005 period. We denote by t^G_{pgt} the ad-valorem (%) tariff on good product p imported from country g at time t.[10]

Our measure of services trade restrictions is based on the OECD Product Market Regulation (PMR) index. More precisely, we use PMR data on the Accounting, Legal, Architectural, Engineering, Telecom, Post, and Air, Rail and Road Transport sectors, which we map into our Balance of Payments categories using the correspondence provided in Table 1 in the online appendix.[11] The main advantage of using PMR data is that they cover service sector restrictions *over time and for multiple sectors*. Alternative datasets such as the World Bank SRI or the OECD STRI include more countries and/or finer service categories coverage, but their coverage only starts after the end of our sample period and, for the World Bank's SRI, is only available for a single year (usually 2008).[12]

While the OECD PMR mainly captures domestic regulation which is *de jure* non-discriminatory (i.e., the restrictions are applied by Belgium to all firms regardless of the origin country), *de facto* it represents a potentially serious obstacle to cross-border trade (Crozet et al., 2016). This is because domestic regulation is usually designed with domestic suppliers in mind. This makes it harder for foreign service suppliers to serve the market as they have to comply with the same regulations (which in addition is often different from the one they face in their home market). Furthermore, the PMR index has a "barriers to trade and investment" component which directly captures regulations that are discriminatory against foreign providers. Other papers (e.g. Crozet et al., 2016) have used the OECD PMR index as a measure of services trade barriers for the same

[9] See Mion and Zhu (2013) for further details.

[10] In a relative small amount of cases the information on tariffs is missing. In such cases we record tariffs as zero and assign a value of one to a dummy that we use alongside the tariffs data to construct an additional control. More specifically we construct, building on the formula for firm-specific weighted import barriers for goods described below, a measure of the share of goods imports value of firm k from country g at time t for which we have no information on the goods trade cost t^G_{pgt}. This additional control is used throughout our estimations.

[11] Since the data for the Accounting, Legal, Architectural, Engineering sectors are available only for 1998, 2003 and 2008, we impose a linear interpolation for the missing years in order to cover the entire period of our analysis. For the few Balance of Payments categories for which there is no PMR data we recode them as zero and assign a value of one to a dummy, that we use alongside the PMR index, to construct an additional control. More specifically we construct, building on the formula of firm-specific weighted import barriers for services described below, a measure of the share of service import values of firm k from country s at time t for which we have no information on the services trade cost t^S_{pst}. This additional control is used throughout our estimations.

[12] The OECD STRI now has data for several years (2014-2017) but coverage only starts almost ten years after the end of our sample period in 2005, making it unsuitable for our analysis.

reasons.

Now, while the PMR index varies across sectors and over time, it does not vary across the origin countries from which Belgium imports. To allow for variation along this dimension, we interact the PMR index with data from the WTO Regional Trade Agreement dataset, which indicates whether a country has a trade agreement covering trade in services with another country.[13] Therefore our measure of services trade barriers combines the PMR index and the WTO data in the following way:

$$t^S_{pst} = PMR_{pt} \times RTA_{st}$$

where PMR_{pt} denotes the PMR index for the service product p at time t corresponding to Belgium and RTA_{st} takes a value of one in the *absence* of an RTA between Belgium and country s covering trade in services at time t, and zero otherwise. This interaction between PMR_{pt} and RTA_{st} broadly captures the differential obstacles faced by a firm exporting service p to Belgium depending on whether the country of the firm has in place a services trade agreement with Belgium or not. A firm coming from a country that has no services trade agreement with Belgium is deemed to face higher de facto or de jure discriminatory restrictions to services trade.[14]

We acknowledge that there is some debate as to whether RTAs with service components actually reduce services trade barriers as opposed to simply reaffirming GATS commitments that are often less liberal than actual trade regimes (e.g., Borchert et al. (2014)). However, in practice most of the geographic and time variation in our RTA dummy is driven by EU membership (also coded as $RTA_{st} = 0$) whose single market programme, while still incomplete, is arguably the most successful initiative for reducing cross-country services trade barriers.[15]

Equipped with measures of goods and services trade barriers t^G_{pgt} and t^S_{pst}, we are in a position to construct firm-specific weighted import barriers as follows:

[13] Available at http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx. These data are based on the compulsory notification of the establishment of a Regional Trade Agreement (RTA) to the WTO by the parties concerned with indication of the content and scope of the agreement. Therefore, we are able to track the countries involved in the agreement, the date of the agreement and whether it includes services, goods or both.

[14] In an additional robustness check reported below, we have also constructed an alternative service barrier measure by interacting the OECD's SRI for 2008 with the same trade agreement dummy variable, $t^S_{pst} = SRI_p \times RTA_{st}$. Note that the time variation of this alternative measure is entirely driven by the RTA dummy.

[15] The EU has also negotiated a range of free trade agreements with non-EU countries that came into force during or before our sample period. However, most of these were either with small trading partners (and hence not among the top-50 origin countries we use) or did not contain a services trade component. The 2000 trade agreement with Mexico is the one important exception here. Overall, $RTA_{st} = 0$ for on average 75 per cent of service imports in our estimation sample. Of course, $t^S_{pst} = 0$ does not imply that there are no restrictions but simply captures the average barriers for the trade with members of that group (mostly EU countries).

$$t^G_{gkt} = \sum_p \varphi_{kp} t^G_{pgt} \qquad \text{where} \quad \varphi_{kp} = \frac{\sum_t \sum_g Imp^{goods}_{pgkt}}{\sum_p \sum_t \sum_g Imp^{goods}_{pgkt}}$$

$$t^S_{skt} = \sum_p \phi_{kp} t^S_{pst} \qquad \text{where} \quad \phi_{kp} = \frac{\sum_t \sum_s Imp^{services}_{pskt}}{\sum_p \sum_t \sum_s Imp^{services}_{pskt}}$$

where p indicates the good or service product, k the firm, g (s) the origin country of goods (services), t the year and Imp^{goods}_{pgkt} ($Imp^{services}_{pskt}$) corresponds to imports of goods (services).

Constructing firm-specific trade barriers in this way allows us to exploit the product dimension of our data to some extent, even though we cannot use it for the main analysis due to computational constraints. Notice also that the weights are time- and origin-invariant and measure the importance of a given imported good or service for the firm. The idea behind this approach is to capture the set of trade barriers that are relevant to firm k, rather than using cruder proxies such as industry affiliation. For example, if firm k has ever imported good g, this means that g is likely to be of value to firm k (possibly because it is a production input). So firm k will be affected by higher trade barriers on good g, irrespective of whether it is currently importing it or not.[16] Using time-origin-invariant weights also reduces concerns with a potentially spurious correlations between import flows and our trade barrier measures. In our robustness checks below, we will also experiment with using firm-product weights based on 1995-2000 import patterns while estimating the model only for the time frame 2001-2005.

The basic combined dataset of import values and import barriers for goods (services) at the firm-origin-year level comprises 1,239,294 (1,041,486) observations. Mean, median and standard deviation of import values (million euros) and import barriers are provided in Table 3.

Table 3: Some Sample Descriptives

	Obs	Mean	Median	St. Dev.
Goods Imports Imp^{goods}_{gkt}	1,239,294	5.012	0.098	70.214
Services Imports $Imp^{services}_{skt}$	1,041,486	1.376	0.080	15.962
Goods Tariffs t^G_{gkt}	1,239,294	0.626	0.000	1.966
services trade Barriers t^S_{skt}	1,041,486	0.512	0.000	1.038

[16] An alternative approach would be to use domestic input usage to construct our weights. Unfortunately, such information is not available to us and explains why we need to focus on firms that have imported goods and services at least once.

2.2 Key Features of the Data

In this section, we outline three features of the data that will guide the construction of our theoretical model.

Fact 1: *The probability of observing a joint service-good flow is low but substantially higher than the product of the probabilities of observing them separately.*

As documented in numerous studies, firm-level imports are sparsely distributed across countries and years. In our sample positive goods imports are observed in 11.7% of all the possible firm-country-year triples and services imports only 5.6% of the time. Therefore, there is a high number of zeros in the data. While import flows of either type are sparse, a key feature of the combined data is that imports of goods and services from the same country are extremely frequent. To see this, consider the count of firm-year pairs with positive imports of goods from g and services from s. The frequency of joint imports ($g = s$) is five times higher than the product of the marginal frequencies for all countries. This raw statistic suggests the existence of a strong complementarity between goods and services imports from the same country. Note that such complementarity cannot be explained by simple comparative advantage and/or trade cost patterns arguments. For example, if the US has a comparative advantage in computers (goods) and computer services (services), both the probability of joint imports from the US and the product of the marginal probabilities will be high and should be roughly comparable.[17]

Fact 2: *Importing both goods and services from the same country is associated with higher productivity.*

The higher propensity of purchasing goods and services from the same country just highlighted could point to complementarities coming from a productivity channel. For example, the productivity of US computers might be enhanced by the use of US computer services. This could arise if the US firm selling the computer tailors the services to the good or even uses the services to make the goods more relationship-specific, as in the case of maintenance, leasing or "business solutions".

[17] For further information, in online Appendix Table 3 we list the products and services that are most frequently sourced from the same country in our data, and in Table 4 we show the countries from which joint sourcing occurs most frequently. Interestingly, two service types often associated with business solutions in the servitization sense discussed above, financial and business services, account for the majority of occurrences in Table 3. Note that at least for financial services, this dominance is not present when looking at import shares (see Table 2) although we are of course only looking at a small share of all transactions in Table 3. The ranking of origin countries by the frequency of sourcing decisions in Table 4 does not vary noticeably when looking at goods imports, services imports or joint sourcing. However, the dominance of the top origins increases somewhat in the latter sample.

To provide descriptive evidence for the relevance of this channel we proceed in two steps. In the first step, we compare - within the same industry and year - the productivity of firms that purchase both goods and services from the same country with the productivity of those firms that purchased goods and services from different countries. We do so by regressing different measures of productivity on a dummy that takes the value one if the firm imports both goods and services from the same country ($I^{GS}_{g=s}$) as well as on a battery of industry-year dummies. Table 4 shows that firms importing both goods and services from the same country outperform other firms in all of the productivity measures we use.[18]

Table 4: Productivity premia of firms importing goods and services from the same country

Dep. Var.:	$\ln \frac{VA}{L}$	$\ln \frac{Sales}{L}$	OLS TFP	LP TFP
$I^{GS}_{g=s}$	0.2272^a	0.2818^a	0.2792^a	0.2480^a
	(0.004)	(0.006)	(0.004)	(0.005)
Industry-Year FE	Yes	Yes	Yes	Yes
Observations	257,529	243,571	253,514	253,514
R-squared	0.1192	0.1795	0.1305	0.1000

Note: $\ln \frac{VA}{L}$ is value added per worker, $\ln \frac{Sales}{L}$ sales per worker, OLS TFP is the TFP residual of an OLS regression where log value added is regressed on log labor and capital, and LP TFP is TFP measured using the Levinsohn and Petrin (2003) routine. Standard errors clustered at the firm-level in parentheses. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

To go beyond this static fact, in the second step we provide evidence on productivity dynamics of these firms. In particular we compare, by means of a firm fixed-effects regression, their productivity before and after they start importing both goods and services from the same country with the productivity of firms that import goods and services from different countries for the whole period. The results for this difference-in-difference regression presented in Table 5 reveal that firms that start importing both goods and services from the same country increase their productivity significantly more than the other firms sourcing from different markets.

[18] This difference remains significant when the comparison group is further split into firms that import goods and services from different destinations and firms that import only goods or services, or when we restrict the sample to the firms actually used in the estimations for the quantitative exercise - e.g. the ES sample presented in Table 1. The results are also robust to adding the number of exported products as a further covariate that is potentially correlated with both firm productivity and the probability to source goods and services from the same origin. These additional results are available from the authors on request.

Therefore, our descriptive evidence suggests that importing both inputs from the same country is associated with higher productivity. Our model in Section 3 will capture this feature via a technological complementarity between inputs of the same country. Section 3 will present our proposed mechanism in depth and discuss how to rule out alternative explanations of Fact 1, such as savings on country-specific fixed costs.

Table 5: Productivity growth of firms importing goods and services from the same country

Dep. Var.:	$\ln \frac{VA}{L}$	$\ln \frac{Sales}{L}$	OLS TFP	LP TFP
$I^{GS}_{g=s}$	0.0136^{a}	0.0670^{a}	0.0134^{a}	0.0102^{c}
	(0.005)	(0.005)	(0.004)	(0.006)
Firm and Year FE	Yes	Yes	Yes	Yes
Observations	257,529	243,571	253,514	253,514
R-squared	0.7198	0.8667	0.7114	0.6230

Note: $\ln \frac{VA}{L}$ is value added per worker, $\ln \frac{Sales}{L}$ sales per worker, OLS TFP is the TFP residual of an OLS regression where log value added is regressed on log labor and capital, and LP TFP is TFP measured using the Levinsohn and Petrin (2003) routine. Standard errors clustered at the firm-level in parentheses. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Fact 3: *Controlling for both firm-year and country unobservables, goods trade barriers are negatively correlated with service imports and vice versa.*

Our third fact highlights another form of interdependency between goods and services sourcing decisions, namely that goods trade barriers reduce the likelihood of importing services from the same country, and the other way around. To show this, we separately model the choice of importing goods and the choice of importing services from a given origin country by firm k at time t. For each firm-year pair in the data for which we observe imports from at least one origin, we construct the dummy I^{G}_{gkt} taking a value of one if firm k imports goods from country g at time t and zero otherwise (i.e., if the firm imports from two out of fifty possible origins, $I^{G}_{gkt} = 1$ for two firm-destination-year observation and zero for the remaining 48). $I^{S}_{gkt} = 1$ is defined accordingly.

We model the sourcing decision as depending on both goods and services trade barriers as well as firm-time fixed effects and country dummies:

$$I^G_{gkt} = d_g + d_{kt} + \beta^S_1 t^S_{gkt} + \beta^G_1 t^G_{gkt} + \eta^G_{gkt} \quad (1)$$

$$I^S_{skt} = d_s + d_{kt} + \beta^S_2 t^S_{skt} + \beta^G_2 t^G_{skt} + \eta^S_{skt} \quad (2)$$

where, for example, t^S_{gkt} is the service import barrier of firm k at time t corresponding to country g, i.e., the same country for which we consider the goods import barrier (s=g). Country dummies d_g and d_s control for gravity determinants of trade flows while firm-year fixed effects d_{kt} control for unobserved idiosyncratic shocks that may affect the import decision. We estimate a conditional logit model and cluster standard errors at the firm-year level.[19] Results are reported in Table 6.

Table 6: Reduced-form estimates of the impact of services trade barriers on goods sourcing choices, and vice versa

	Goods	**Services**
	(1)	(2)
Dep. Var.:	$I^G_{gkt} = 1$	$I^S_{skt} = 1$
Goods trade barriers	-0.0480^a	-0.0183^a
	(0.0026)	(0.0029)
services trade barriers	-0.0061	-0.0618^a
	(0.0044)	(0.0069)
Firm-Year fixed effects	Yes	Yes
Country Dummies	Yes	Yes
Observations	5,209,100	3,123,400
Pseudo R-squared	0.3999	0.3981
Number of firm-years	104,182	62,468

Note: Firm-time clustered standard errors in parentheses. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

We find that both types of trade barriers have a negative effect on both types of trade. The probability to import services from a given origin country is negatively and significantly correlated with both goods and services trade barriers. At the same time, the probability to import goods is negatively and significantly correlated with

[19]It would have been perhaps desirable to cluster standard errors at the country level. However, this is technically not possible when having fixed effects d_{kt} in the regression. Indeed, in order to operate clustering of standard errors in fixed effects models, individuals (a firm-time pair in our setting) should be nested within clusters while in our regression the same firm-year could span into several clusters (countries).

goods trade barriers. In the same regression the coefficient of services trade barriers is negative but fails (not by much) to be significant. We check that the correlation between t^G_{gkt} and t^S_{skt}, which is equal to 0.339, is positive as expected but not large enough to generate multi-collinearity and prevent identification. As a further check we run the same regression on a sample that excludes Vehicles from goods and Transportation from services, as those are likely to capture global value chains trade. We find very similar results, which we report in Panel a of Table 5 in the online appendix.

Interpreting coefficients in Table 6 is difficult because the conditional logit model does not allow us to recover meaningful marginal effects. Yet, if we run the same two estimations with a linear probability model (Panel b, Table 5 in the online appendix), all coefficients are highly significant and we get the following insights. Considering the first regression, the expectation of I^G_{gkt} in the data, i.e., the probability that $I^G_{gkt} = 1$, is 0.1166. The coefficients of goods and services trade barriers are such that a one standard deviation increase of such barriers would reduce the probability of importing goods from a given country by 0.0060 (goods barriers) and 0.0069 (services barriers) probability units, i.e., roughly 5% and 6% of the unconditional probability. Moving to the second regression, a one standard deviation increase in barriers would reduce the probability of importing services from a given country by 0.0007 (goods barriers) and 0.0041 (services barriers) probability units, i.e., roughly 1% and 7% of the unconditional probability.

3 Theory

In what follows we present a simple sourcing model that will be used to guide our empirical analysis. The model is simple in many respects and we will subsequently relax some of its assumptions in order to cope with the richness of the actual data. This means our framework does not correspond to a structural approach. Yet, the theoretical model is useful in that it provides guidance on how to combine and interpret parameters as well as on how to deal with selection bias in a consistent and parsimonious way.

3.1 Households

There are C countries with identical preferences and market structure. To save notation and match our empirical application we focus on a single importing country and drop country subscripts in most of the exposition. There are L consumers with inelastic unit labor supply. Define the representative consumer's utility function as:

$$U(A, \{M_p\}) = A^{1-\beta} \prod_{p=1}^{\mathcal{P}} (M_p)^{\beta_p} \tag{3}$$

where A denotes consumption of the freely tradable numeraire good A, $\sum_p \beta_p = \beta$, $0 < \beta < 1$ and

$$M_p = \left(\int_0^{N_p} q_{pk}^{\frac{\sigma-1}{\sigma}} dk \right)^{\frac{\sigma}{\sigma-1}}$$

denotes consumption of a composite final product p (see below) and $\sigma > 1$.

National income equals labor income and profits. We assume that each worker has an equal share in a perfectly diversified international portfolio. Given that our assumptions about production technology in the numeraire sector imply wages of unity everywhere (see below), it follows that national income is given by:

$$Y = L + \frac{L}{L_w} \Pi_w \tag{4}$$

where Π_w denotes world profits, which will be determined endogenously below, and L_w denotes world population.

3.2 Final sector

A sector. Good A is produced out of labor under the following linear technology:

$$A = F(L_A) = L_A \tag{5}$$

where L_A denotes labor use by sector A. We assume that A is costlessly tradable and that all countries produce that good, so that wages equal one everywhere.[20]

M sector: demand. There are $\mathcal{P}$ nontradable final products. For each product domestic markets are monopolistically competitive. Given (3) demand for variety k of final good p equals:

$$q_{pk} = \beta_p Y \frac{p_{pk}^{-\sigma}}{P_p^{1-\sigma}} \tag{6}$$

[20] Sector A may be thought of as agriculture. Having constant wages simplifies the analysis of import choices considerably. In the empirical part of this paper we will control for cross-country differences in wages with country fixed effects. Also, the quantification exercise will be restricted to non-drastic trade policy changes, which makes it easier to abstract from trade-driven wage changes.

where $P_p \equiv \left(\int_0^{N_p} p_{pk}^{1-\sigma} dk\right)^{\frac{1}{1-\sigma}}$ and N_p is the mass of varieties of product p consumed in the country.

M sector: supply. As in Bernard et al. (2011) we assume that varieties of each product p are differentiated by brand and that each firm owns exactly one brand. Hence, while firms can be active in different product markets, they can only provide one variety per product.[21] Unlike Bernard et al. (2011), however, the number of firms and production lines is assumed constant throughout the analysis. We make this simplifying assumption because we are interested in a firm's input choice problem rather than its choice of product mix as Bernard et al. (2011).

A production line making variety pk of final good p requires two types of inputs: goods (G) and services (S). Goods and services are differentiated by origin country, and each country produces a single variety g and a single variety s (an Armington assumption).[22] We assume that each production line uses *only one good g and one service s*[23] to produce output q_{pk} using a constant-returns Cobb-Douglas technology:[24]

$$\forall p, \forall k, q_{pk}(q_{gpk}, q_{spk}) = \Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k q_{gpk}^{\alpha} q_{spk}^{1-\alpha} \tag{7}$$

where q_{gpk} and q_{spk} represent quantities of intermediate good g and service s used by production line pk and $0 < \alpha < 1$. $\lambda_g > 1$ and $\lambda_s > 1$ capture the quality of inputs g and s. Θ_{gs} is a parameter that takes value $\Theta \geq 1$ if both inputs are sourced from the same country, and value 1 otherwise.[25] φ_k is a firm-specific TFP parameter, while ξ_{gspk} is a random variable whose properties are explained below.

[21]As a result multiproduct firms have negligible mass on the continuum of varieties, although they may produce a positive mass of products. This rules out strategic interaction in the pricing decisions of products of the same firm. As is well-known, relaxing the negligibility assumption makes the analysis of monopolistic competition substantially more complicated (Thisse and Ushchev, 2016).

[22]Formally g and s depend on pk, but we choose not to denote them $g(pk)$ and $s(pk)$ to save on notation.

[23]In the data we observe firms importing goods and services from multiple countries. Taken together, our assumptions imply that each good-service import pair is chosen separately on each production line. This simplifying assumption yields tractable expressions which helps us handle the size of the dataset used in the estimation (see below for details). We also note that the model is consistent with one further stylized fact in the data: firms that import from more origin countries also produce more products (as proxied by the number of *exported* products). Specifically, a 10% increase in the number of imported products is associated with a 5.8% increase in the number of exported products.

[24]The model could easily accommodate the more general case of a CES production function, with an elasticity of substitution either above or below the benchmark value of one. However, when turning to estimation some key parameters would not be identified due to non-linearities. Indeed random utility models, like the one we will spell out below, cannot handle non-linearity in parameters. The production function could also have labor as an additional factor, though the unit wages assumption makes the omission innocuous. We thank an anonymous referee for pointing this out.

[25]This assumption, which is motivated by Fact 1, is discussed at length in Section 3.5.

Our assumptions on demand and supply imply that optimal input choices on any two production lines pk and $p'k'$ are independent, even within the same firm. Conditional on choosing inputs g and s,[26] the cost-minimizing input demands of production pk equal:

$$q_{gpk} = \frac{1}{\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k}\left(\frac{\alpha p_s}{(1-\alpha)p_g}\right)^{1-\alpha} q_{pk} \tag{8}$$

$$q_{spk} = \frac{1}{\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k}\left(\frac{(1-\alpha)p_g}{\alpha p_s}\right)^{\alpha} q_{pk} \tag{9}$$

so that marginal cost does not depend on scale and equals

$$c_{pk} = \frac{\Gamma p_g^{\alpha} p_s^{1-\alpha}}{\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k}$$

where $\Gamma = \alpha^{-\alpha}(1-\alpha)^{\alpha-1}$ is a positive constant.

Given $(p_g, p_s, \lambda_g, \lambda_s, \Theta_{gs}, \xi_{gspk}, \varphi_k)$ and the price index P_p, the producer of line pk solves

$$\max_{\{p_{pk}\}}\{(p_{pk} - \frac{\Gamma p_g^{\alpha} p_s^{1-\alpha}}{\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k})\left(\beta Y \frac{p_{pk}^{-\sigma}}{P_p^{1-\sigma}}\right)\} \tag{10}$$

which yields the following optimal price

$$p_{pk} = \frac{\sigma}{\sigma-1}\frac{\Gamma p_g^{\alpha} p_s^{1-\alpha}}{\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k} \tag{11}$$

Final production of pk equals

$$q_{pk} = \beta_p Y \left(\frac{\sigma-1}{\sigma}\frac{\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k}{\Gamma p_g^{\alpha} p_s^{1-\alpha}}\right)^{\sigma} P_p^{\sigma-1} \tag{12}$$

so that the profits derived from the production of pk equal

$$\pi_{pk} = \frac{1}{\sigma}\beta_p Y \left(\frac{\sigma-1}{\sigma}\frac{\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k}{\Gamma p_g^{\alpha} p_s^{1-\alpha}}\right)^{\sigma-1} P_p^{\sigma-1} \tag{13}$$

and corresponding log profits on production line pk are given by

$$\ln \pi_{pk} = \ln\left(\frac{1}{\sigma}\beta_p Y (\frac{\sigma-1}{\sigma}P_p)^{\sigma-1}\right) + (\sigma-1)\ln\Theta_{gs} + (\sigma-1)\ln\left(\frac{\lambda_g\lambda_s}{\Gamma p_g^{\alpha} p_s^{1-\alpha}}\right) + (\sigma-1)\ln\varphi_k + (\sigma-1)\ln\xi_{gspk} \tag{14}$$

We now turn to the choice of g and s by each production line.

[26] Sourcing decisions are analyzed in the next subsection.

3.3 Intermediate goods and services sector

Choice of supplier We assume that suppliers price at marginal cost, inclusive of iceberg trade costs.[27] We also assume goods and service inputs bear iceberg trade costs $\tau_g \geq 1$ and $\tau_s \geq 1$ with $\tau_g = 1$ ($\tau_s = 1$) if the good (service) is sourced domestically.

We assume that one unit of intermediate goods (services) is produced out of c_g (c_s) units of labor. Marginal cost pricing implies

$$p_g = \tau_g c_g \tag{15}$$

$$p_s = \tau_s c_s. \tag{16}$$

Each pair of good g and service s is characterized by a random productivity component $\ln \xi_{gspk}$ which is known and idiosyncratic to production line pk. For each gs pair, we treat $\ln \xi_{gspk}$ as a set of iid random variables following a Gumbel distribution with cumulative distribution function

$$F(x) = \exp\left[-\exp[-(\frac{x}{\mu} + \gamma)]\right]$$

and density

$$f(x) \equiv \frac{dF(x)}{dx} = \frac{1}{\mu}\exp[-(\frac{x}{\mu} + \gamma)]\exp\left[-\exp[-(\frac{x}{\mu} + \gamma)]\right]$$

where $\mu > 0$ and γ is the Euler constant. Our assumptions imply that each production line's draw of $\ln \xi_{gspk}$ for a given gs pair is independent of draws for other gs pairs as well as other lines' draws. Consistent with this assumption, $\ln \xi_{gspk}$ is also assumed to be independent of φ_k.

Within a product line, each purchase of a good-service combination is therefore an independent choice between the C^2 possible pairs of origin countries.[28] Given (14), a production line manager chooses a sourcing country g for goods and s for services to maximize (a monotonic transformation of):

$$\ln \Theta_{gs} + \ln\left(\frac{\lambda_g \lambda_s}{(\tau_g c_g)^\alpha (\tau_s c_s)^{1-\alpha}}\right) + \ln \varphi_k + \ln \xi_{gspk}.$$

This can be interpreted as a multinomial logit linear random utility model[29] where

[27] This follows from the Armington assumption and ensures tractability. The setup could be extended to exogenous country-specific markups, but more sophisticated pricing strategies would prevent us from finding a closed-form solution for country pairs' markets shares.

[28] Note, however, that output and profitability across production lines within the same firm will still be correlated because of the existence of the firm-specific TFP parameter, φ_k.

[29] See Anderson et al. (1992) for a textbook treatment.

pk maximizes utility $\tilde{U}_{gspk} = u_{gspk} + \ln \xi_{gspk}$ with

$$u_{gspk} = \ln \Theta_{gs} + \ln \lambda_g + \ln \lambda_s - \alpha \ln(\tau_g c_g) - (1-\alpha)\ln(\tau_s c_s) + \ln \varphi_k$$

Given distributional assumptions on $\ln \xi_{gspk}$, the probability that production line pk uses a particular good-service combination gs is given by:

$$s_{gspk} = \frac{(\varphi_k)^{\frac{1}{\mu}}\left(\frac{\Theta_{gs}\lambda_g\lambda_s}{(\tau_g c_g)^{\alpha}(\tau_s c_s)^{1-\alpha}}\right)^{\frac{1}{\mu}}}{(\varphi_k)^{\frac{1}{\mu}}\sum_{gs}\left(\left(\frac{\Theta_{gs}\lambda_g\lambda_s}{(\tau_g c_g)^{\alpha}(\tau_s c_s)^{1-\alpha}}\right)^{\frac{1}{\mu}}\right)} = \frac{\left(\frac{\Theta_{gs}\lambda_g\lambda_s}{(\tau_g c_g)^{\alpha}(\tau_s c_s)^{1-\alpha}}\right)^{\frac{1}{\mu}}}{\sum_{gs}\left(\left(\frac{\Theta_{gs}\lambda_g\lambda_s}{(\tau_g c_g)^{\alpha}(\tau_s c_s)^{1-\alpha}}\right)^{\frac{1}{\mu}}\right)} \equiv s_{gs} \tag{17}$$

Notice that the idiosyncratic TFP parameter φ_k cancels out.

Conditional input demand Given (8), (12), (15) and (16), pk's demand for intermediate good g *conditional on choosing* gs equals

$$\begin{aligned} q_{gpk} &= \frac{1}{\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k}\left(\frac{\alpha p_s}{(1-\alpha)p_g}\right)^{1-\alpha}\beta_p Y\left(\frac{\sigma-1}{\sigma}\frac{\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k}{\Gamma p_g^{\alpha}p_s^{1-\alpha}}\right)^{\sigma} P_p^{\sigma-1} \\ &= \left(\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k\right)^{\sigma-1}\left(\tau_s c_s\right)^{(1-\sigma)(1-\alpha)}\left(\tau_g c_g\right)^{\alpha-1-\alpha\sigma}\underbrace{\left(\frac{\alpha}{(1-\alpha)}\right)^{1-\alpha}\left(\frac{\sigma-1}{\sigma}\frac{1}{\Gamma}\right)^{\sigma}\beta_p}_{B_p} Y P_p^{\sigma-1} \end{aligned} \tag{18}$$

The value of purchased intermediate goods is thus:

$$p_g q_{gpk} = \left(\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k\right)^{\sigma-1}\left(\tau_s c_s\right)^{(1-\sigma)(1-\alpha)}\left(\tau_g c_g\right)^{\alpha(1-\sigma)} B_p Y P_p^{\sigma-1} \tag{19}$$

Similarly, k's demand for intermediate services s equals:

$$\begin{aligned} q_{spk} &= \frac{1}{\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k}\left(\frac{(1-\alpha)p_g}{\alpha p_s}\right)^{\alpha}\beta_p Y\left(\frac{\sigma-1}{\sigma}\frac{\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k}{\Gamma p_g^{\alpha}p_s^{1-\alpha}}\right)^{\sigma} P_p^{\sigma-1} \\ &= \left(\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k\right)^{\sigma-1}\left(\tau_s c_s\right)^{(1-\sigma)(1-\alpha)-1}\left(\tau_g c_g\right)^{\alpha(1-\sigma)}\underbrace{\left(\frac{\alpha}{(1-\alpha)}\right)^{-\alpha}\left(\frac{\sigma-1}{\sigma}\frac{1}{\Gamma}\right)^{\sigma}\beta_p}_{B'_p} Y P_p^{\sigma-1} \end{aligned} \tag{20}$$

and the value of purchased intermediate services equals:

$$p_s q_{spk} = \left(\Theta_{gs}\xi_{gspk}\lambda_g\lambda_s\varphi_k\right)^{\sigma-1}\left(\tau_s c_s\right)^{(1-\sigma)(1-\alpha)}\left(\tau_g c_g\right)^{\alpha(1-\sigma)} B'_p Y P_p^{\sigma-1} \tag{21}$$

Notice in (19) and (21) that an increase in goods iceberg trade costs reduces imports of services, and vice versa. This holds irrespective of whether the sourcing country is the same for goods and services ($g = s$). Also note this result holds in our Cobb-Douglas specification in which goods and services are neither complements nor substitutes.

3.4 Closing the model

Price Index Recall that

$$P_p \equiv \left(\int_0^{N_p} p_{pk}^{1-\sigma} dk \right)^{\frac{1}{1-\sigma}}$$

where $p_{pk} = \frac{\sigma}{\sigma-1} \frac{\Gamma c_g^{\alpha} \tau_g^{\alpha} c_s^{1-\alpha} \tau_s^{1-\alpha}}{\Theta_{gs} \xi_{gspk} \lambda_g \lambda_s \varphi_k}$. From equation 2.25 in Anderson et al. (1992) we know that the probability of choosing a particular country pair gs, i.e., the probability that $\tilde{U}_{gspk}$ is maximal across country pairs, can be written as:

$$s_{gs} = \int_{-\infty}^{\infty} f(x) \prod_{qr \neq gs} F(u_{gspk} - u_{qrpk} + x) dx,$$

where $F(.)$ refers to the Gumbel cumulative distribution function and $f(\cdot)$ its density. The term inside the integral represents the probability density of $\ln \xi_{gspk}$ being equal to x and x being such that gs is chosen. Recalling that all production lines draw from the same Gumbel distributions irrespective of φ_k we can write:

$$P_p = \left(\sum_{gs} \left(\frac{\sigma}{\sigma - 1} \frac{\Gamma c_g^{\alpha} \tau_g^{\alpha} c_s^{1-\alpha} \tau_s^{1-\alpha}}{\Theta_{gs} \lambda_g \lambda_s} \right)^{1-\sigma} E\left[\varphi_k^{\sigma-1}\right] \int_{-\infty}^{\infty} \mathrm{e}^{x^{\sigma-1}} f(x) \prod_{qr \neq gs} F(u_{gspk} - u_{qrpk} + x) dx \right)^{\frac{1}{1-\sigma}} \tag{22}$$

Aggregate Profits and National Income We now index importing countries by subscript d.

Marginal cost pricing in the intermediate sector implies that only final sector firms earn profits. Aggregate world profits enter national income as seen in (4). As discussed, we further assume that the number of firms N_d and each firm's number of products $\{N_{dk}\}$ are exogenous, in the spirit of Chaney (2008). Note that $N_{dk} \leq \mathcal{P}_d$, meaning that not all firms are active in all products.

World profits are equal to:

$$\begin{aligned}
\Pi_w &\equiv \sum_d^C \int_0^{N_d} \left(\sum_p^{N_{dk}} \pi_{dpk} \right) dk \\
&= \sum_d^C \int_0^{N_d} \left(\sum_p^{N_{dk}} \frac{\beta_p Y_d}{\sigma} \left(\frac{\sigma}{\sigma - 1} c_{dpk} \right)^{1-\sigma} P_{dp}^{\sigma-1} \right) dk \\
&= \sum_d^C \sum_p^{\mathcal{P}_d} \frac{\beta_p Y_d}{\sigma} P_{dp}^{\sigma-1} \int_0^{N^{dp}} p_{dpk}^{1-\sigma} dk \\
&= \sum_d^C \sum_p^{\mathcal{P}_d} \frac{\beta_p Y_d}{\sigma} \\
&= \frac{\beta Y_w}{\sigma}
\end{aligned}$$

where $Y_w = \sum_d Y_d$.

This implies

$$Y_w = L_w + \Pi_w = \frac{\sigma}{\sigma - \beta} L_w$$

and

$$\Pi_w = \frac{\beta}{\sigma - \beta} L_w$$

so that

$$Y_d = \frac{\sigma}{\sigma - \beta} L_d \tag{23}$$

3.5 The importance of Θ_{gs}

The Θ_{gs} component in the production function (7) takes a higher value when inputs from the same country are combined together. We show below that this parameter implies a greater probability of sourcing goods and services inputs from the same country, a key feature of the data which we labelled Fact 1 in Section 2. The Θ_{gs} assumption also implies that, everything else equal, import values conditional on importing are higher when inputs come from the same country. That second implication helps discriminate between our and an alternative mechanism that may also explain Fact 1, namely fixed costs savings from jointly importing goods and services from the same country. In our estimations in Section 4 we allow for both Θ_{gs} and fixed costs to affect importing behavior.

Θ_{gs} may capture a number of economic mechanisms. Firstly, it may capture that there is an advantage if the same exporting firm supplies both g and s.[30] This is the

[30] Ariu et al. (2018) shows that about 10% of Belgian exporters offer both goods and services together,

case when: i) The good and/or the service are of higher quality if bought from the same firm. For example, the presence of the service may increase the perceived quality of the good.[31] Relatedly, some intangibles owned by the supplier, such as ISO9000 quality certification or a reputation for quality, may have non-rival effects on g and s.[32] In addition, proprietary knowledge can give an advantage to original component manufacturers in tailoring services to their own goods, or using the services to make the goods more relationship-specific. This is likely in the case of maintenance, leasing or "business solutions" that outsource some of the downstream firm's tasks. ii) A parent multinational firm provides specific "headquarter" services along with intra-firm goods trade to an affiliate. iii) Transaction or search costs are high and/or there are economies of scope in producing both products. Secondly, Θ_{gs} may capture country-specific complementarity in goods and services, resulting for instance from service providers being more familiar with national goods. In the case of engineering, design, consulting, maintenance or monitoring services, that familiarity is likely to make goods and services of the same origin more complementary than with varieties of other countries. Unfortunately, the lack of data on exporters in our import dataset prevents us from discriminating between these stories. For that reason, we refrain from providing more specific micro foundations.

Interestingly inputs that are jointly sourced tend to be critical inputs for their importers. To see that, we combine our data with input-output tables for Belgium. We find that goods and services products that are jointly imported from the same country in the same year (SJ sample) are systematically characterized by high weights in the input-output technology of the importing firms. In other words, goods and services that are key to firms in a particular industry are disproportionately sourced abroad from the same country.[33]

Turning back to the model the Θ_{gs} assumption implies that the probability of choosing a particular gs combination in our model is generally different from the product of the marginal probabilities (of sourcing goods from g and services from s). Only in the special case of $\Theta_{gs} = 1, \forall g, s$ the joint probability equals the product of the marginal

accounting for more than 45% of trade.

[31] Ariu et al. (2018) provide empirical evidence supporting this particular mechanism.

[32] According to Bernard et al. (2010) this argument may explain the greater propensity of the most productive Belgian firms to perform "carry-along trade".

[33] More precisely, we assign each firm-year to its corresponding two-digit Nace rev 1.1 main industry affiliation, and use input-output table weights for Belgium broken down at the two-digit Nace rev 1.1 level for the year 2000. We then compute, separately for the SJ and ES samples, equivalent weights based on imported goods and services products. We finally analyze the difference between imports-based weights and input-output weights. We find that products with high input-output weights (key products for firms in a particular industry) have even higher imports-based weights (disproportionately sourced abroad from the same country) in the SJ sample.

probabilities.

To see this, consider the following. Given the finite number of alternative origin country pairs we readily have:

$$\max_{gs}\{\tilde{U}_{gspk}\} = \max_{g}\{\max_{s}\{\tilde{U}_{gspk}\}\} \tag{24}$$

Consider one possible origin country for goods imports, g^*, that may or may not be chosen by pk. Due to the IIA property of the multinomial logit, the probability of sourcing services from country s rather than s^* is the same conditionally on sourcing goods from a particular country g^* or not (see Anderson et al. (1992), p.23, Equation 2.10). Therefore we can start solving problem (24) by choosing a country s among C possible countries to source services from, so as to maximize:

$$\begin{aligned} \hat{U}_{sk}^{g^*} &= u_{spk}^{g^*} + \ln \xi_{spk}^{g^*} \\ \text{where } u_{spk}^{g^*} &= \ln \eta^{g^*} + \ln \Theta_s^{g^*} + \ln \lambda_s - (1-\alpha)\ln(\tau_s c_s) + \ln \varphi_k \end{aligned} \tag{25}$$

where $\eta^{g^*} = \frac{\lambda_{g^*}}{(\tau_{g^*} c_{g^*})^{\alpha}}$ is an irrelevant constant in this problem, $\Theta_s^{g^*}{=}\Theta_{gs}$ for $g{=}g^*$ or equivalently $\Theta_s^{g^*} = \Theta_{g^* s}$, and $\ln \xi_{spk}^{g^*} = \ln \xi_{gspk}$ for $g{=}g^*$ is distributed Gumbel and is iid across firms and alternatives.

This implies that a multinomial logit model can be used to describe this problem. The probability of importing services from a country s conditional on $g{=}g^*$ is given by:

$$s_{spk}^{g^*} = s_s^{g^*} = \frac{\left(\frac{\Theta_s^{g^*}\lambda_s}{(\tau_s c_s)^{1-\alpha}}\right)^{\frac{1}{\mu}}}{\sum_s \left(\left(\frac{\Theta_s^{g^*}\lambda_s}{(\tau_s c_s)^{1-\alpha}}\right)^{\frac{1}{\mu}}\right)}. \tag{26}$$

Note that in general $s_s^{g^*} \neq s_s^{g'}$ because $\Theta_s^{g^*} \neq \Theta_s^{g'}$. Conversely we can find the optimal g given s is equal to a particular s^*. More precisely, for a given source country of services there are equivalent expressions to (25) and (26) leading to:

$$s_{gpk}^{s^*} = s_g^{s^*} = \frac{\left(\frac{\Theta_g^{s^*}\lambda_g}{(\tau_g c_g)^{\alpha}}\right)^{\frac{1}{\mu}}}{\sum_g \left(\left(\frac{\Theta_g^{s^*}\lambda_g}{(\tau_g c_g)^{\alpha}}\right)^{\frac{1}{\mu}}\right)}. \tag{27}$$

Finally note the following. Suppose we set $\Theta_{gs} = 1, \forall g, s$. We will then have $s_s^{g^*} = s_s^{g'} = s_s$ and $s_g^{s^*} = s_g^{s'} = s_g$ with:

$$s_g s_s = \frac{\left(\frac{\lambda_g}{(\tau_g c_g)^\alpha}\right)^{\frac{1}{\mu}}}{\sum_g \left(\left(\frac{\lambda_g}{(\tau_g c_g)^\alpha}\right)^{\frac{1}{\mu}}\right)} \frac{\left(\frac{\lambda_s}{(\tau_s c_s)^{1-\alpha}}\right)^{\frac{1}{\mu}}}{\sum_s \left(\left(\frac{\lambda_s}{(\tau_s c_s)^{1-\alpha}}\right)^{\frac{1}{\mu}}\right)} = \frac{\left(\frac{\lambda_g \lambda_s}{(\tau_g c_g)^\alpha (\tau_s c_s)^{1-\alpha}}\right)^{\frac{1}{\mu}}}{\sum_{gs} \left(\left(\frac{\lambda_g \lambda_s}{(\tau_g c_g)^\alpha (\tau_s c_s)^{1-\alpha}}\right)^{\frac{1}{\mu}}\right)} = s_{gs}, \tag{28}$$

which means that the choice of the sourcing country for goods and services are independent.

4 Estimation

4.1 Econometric Model

The theoretical model delivers three fundamental equations to be estimated:

$$\max_{g,s} \{\tilde{U}_{gspk}\} \tag{29}$$

$$\text{where } \tilde{U}_{gspk} = u_{gspk} + \ln \xi_{gspk}$$

$$u_{gspk} = \ln \Theta_{gs} + \ln \lambda_g + \ln \lambda_s - \alpha \ln(\tau_g c_g) - (1-\alpha) \ln(\tau_s c_s) + \ln \varphi_k$$

$$p_g q_{gpk} = (\Theta_{gs} \xi_{gspk} \lambda_g \lambda_s \varphi_k)^{\sigma-1} (\tau_s c_s)^{(1-\sigma)(1-\alpha)} (\tau_g c_g)^{\alpha(1-\sigma)} B_p Y P_p^{\sigma-1} \tag{30}$$

$$p_s q_{spk} = (\Theta_{gs} \xi_{gspk} \lambda_g \lambda_s \varphi_k)^{\sigma-1} (\tau_s c_s)^{(1-\sigma)(1-\alpha)} (\tau_g c_g)^{\alpha(1-\sigma)} B_p' Y P_p^{\sigma-1}. \tag{31}$$

where $\ln \xi_{gspk}$ is iid across production lines and gs pairs and is distributed Gumbel with shape parameter μ. Equation (29) describes the discrete choice of a gs country pair by production line pk, which yields the multinomial logit choice probabilities in (17). Equations (30) and (31) describe the value of a production line's imports of goods and services *conditional on choosing a particular gs country pair.* An appropriate empirical counterpart to (29-31) will therefore have a conditional multinomial logit selection equation and two outcome equations. To estimate such a model, we use a two-stage estimation method drawing on the theory developed in Lee (1983), and described by Bourguignon et al. (2007).

We extend the theoretical model in four ways in order to bring it to the data. First, we introduce a time dimension, t. Second, we allow for one-time fixed entry costs to start importing from a particular gs pair. Once sunk, these costs make the first-stage choice of origin dependent on past choices, but do not affect second-stage conditional import equations.[34] We use this property as an exclusion restriction. Formally, we

[34] Because these sunk costs vary freely across country pairs, our assumption is also consistent with fixed cost savings from joint imports, as in for instance Antras et al. (2017).

denote by y_{gspkt} a binary variable that takes value one when country pair gs is chosen by firm k on its production line pk in year t, and include the lagged dependent variable $y_{gspk,t-2}$ in the first-stage selection equation, but not in the outcome equations.[35]

Third, we choose to aggregate imports of goods and services over all products, even though we observe imports by product category. This helps reduce the dimensionality of the problem (even with this, our first-stage estimation uses over 250 million observations and includes a large number of dummy variables). We do however exploit some of the information coming from the product dimension by allowing trade costs to vary by firm, country and year: τ_{gkt} and τ_{skt}. More specifically, we exploit the heterogeneity across firms in the trade costs of the specific inputs they import as an additional source of identification and use the proxies outlined in Section 2. In additional results reported below, we will also decompose the overall impact of trade barriers into their effect on the number of products or services imported and on the average imports per product and service.

Finally, we observe sourcing choices by firms rather than production lines in our data. Some firms only import goods and services from one location each, in which case firms and production lines coincide. The majority of firms, however, source from multiple origins and we need to infer production line decisions from the data to make the estimation consistent with our model. In the first stage, our multinomial logit model easily accommodates such multi-origin firms because it allows for multiple 'ones' within groups (i.e., firm-years). To be precise, for each firm-year we have $(51 * 51) - 1 = 2600$ possible pairs of goods and service origin countries.[36] Now assume that, for example, a Belgian firm sources goods from Italy and Germany and services from Germany, France and the Netherlands in a given year. That firm-year has $3 * 2 = 6$ gs pairs: Italy-Germany, Italy-France, Italy-Netherlands, Germany-Germany, Germany-France and Germany-Netherlands. Thus, we have six of the 2600 entries equal to one and the remaining equal to zero in the first stage.

In the second stage, we assign firm imports to country pairs in a way that is consistent with the model's production-line structure. More precisely, the Cobb-Douglas assumption implies that each production line uses goods and services in a proportional way. To continue the previous example, suppose the firm imports three million euros

[35]In the absence of good direct proxies for sunk costs in our data, using a lagged dependent variable seems a natural choice. However, we acknowledge that there could be channels through which past import status directly impacts the level of imports in the second stage, for example through dynamic learning in seller-buyer relationships.

[36]Note that Belgium is a possible origin country. If we only observe service imports but no goods imports for a firm-year, we assume for consistency with our model that the goods input is sourced domestically (likewise for the case where we only observe goods imports). Given our sample restriction to importing firms only, the one origin combination that is not observed is Belgium-Belgium, yielding a total of $(51 * 51) - 1 = 2600$ origin pairs.

of goods from Italy, two million euros of goods from Germany and one million euros of services from each of Germany, France and the Netherlands. The six possible origin combinations are interpreted as six production lines and we assign the common goods and services imports to each of the six pairs proportionally: the Italy-Netherlands pair, for instance, has 1/3 of total goods imports from Italy (1 million euros) and 3/5 of Dutch services imports (0.6 million euros). More generally, we use the following assignment rule

$$\forall g = 1, ...G, Imp^{goods}_{gspkt} \equiv \frac{Imp^S_{skt}}{\sum_c Imp^S_{ckt}} Imp^G_{gkt}$$
$$\forall s = 1, ...S, Imp^{services}_{gspkt} \equiv \frac{Imp^G_{gkt}}{\sum_c Imp^G_{ckt}} Imp^S_{skt}$$

where Imp^G_{gkt} and Imp^S_{skt} denote observed goods imports by firm k in year t from country g and services imports by firm k in year t from country s, respectively. Assigned flows sum up to observed flows and the ratio of goods to services imports remains constant across pairs (production lines).[37]

While this procedure is consistent with our model, we acknowledge that a less restrictive model setup not requiring import assignment in the second stage might have been desirable. However, allowing firms to freely source from multiple goods and services origins simply would have been computationally infeasible. As discussed, our model setup leads to 2600 combinations per firm-year in the data or around 250 million observations in total. By contrast, if firms can import from n_G goods and n_S services origins, we would instead obtain $51^{n_g+n_s} - 1$ potential combinations per firm-year.[38]

To summarize, we estimate the following empirical counterpart to (29-31):

[37] In principle, we could have used a similar assignment rule in the first stage as well. That is, in the above example we could have created six production lines corresponding to firm k with 2600 observations each. For each of these sets of 2600 observations, we would have had only one origin combination coded equal to one, with the remaining 2599 entries equal to zero. This would have had the advantage of strengthening the link between the multinomial logit model and the discrete choice model presented in Section 3. However, it would also have increased the number of observations in our data by a factor of 12.5 (the average number of production lines in the data) leading to about 3 billion observations in the first stage; something clearly computationally infeasible.

[38] Note that an approach not apportioning imports in the second stage would require a number of essentially arbitrary assumptions. To illustrate this, consider the case where a firm imports goods from one location and services from three origins, including the goods origin. In this case, what services trade barrier measures should be included in the goods import regression? All three barriers separately, potentially leading to multicollinearity problems, or some weighted average of the three? Should we then assign a value of one to Θ_{gs} or a value of one third to reflect the fact that part of the input bundle has been sourced from different origins? In this respect our assignment rule comes straight from the explicit assumptions laid down in the theory and provides clear guidance for those issues.

$$
\begin{aligned}
y_{gskt} &= \mathbf{1}_{[\tilde{U}_{gspkt}=\max_{qr}\{\tilde{U}_{qrpkt}\}]} \qquad (32)\\
\tilde{U}_{gspkt} &= a y_{gspk,t-2} + \theta_{gs} + \mathbf{D}_g + \mathbf{D}_s + a_1 t^G_{gkt} + a_2 t^S_{skt} + e_{kt} + e_{gspkt}
\end{aligned}
$$

$$
\begin{aligned}
Imp^{goods}_{gspkt} &= \exp\left[b_0 + \theta_{gs} + \mathbf{D}_g + \mathbf{D}_s + b_1 t^G_{gkt} + b_2 t^S_{skt} + u_{kt} + u_{gspkt}\right] \qquad (33)\\
Imp^{services}_{gspkt} &= \exp\left[c_0 + \theta_{gs} + \mathbf{D}_g + \mathbf{D}_s + c_1 t^G_{gkt} + c_2 t^S_{skt} + v_{kt} + v_{gspkt}\right], \qquad (34)\\
gs &= 1...C^2 - 1,
\end{aligned}
$$

where y_{gskt} is a binary variable that takes value one whenever a particular gs combination is chosen by firm k in year t, i.e., if $\tilde{U}_{gspkt} = \max_{qr}\{\tilde{U}_{qrpkt}\}$ and zero otherwise. Imp^{goods}_{gspkt} and $Imp^{services}_{gspkt}$ are the imports of goods and services from origin pair (production line) gs, computed by assigning total firm imports as described above.

θ_{gs} is a dummy variable that takes a value of one if $g = s$ and the corresponding coefficient in the regression is equivalent to $\ln \Theta_{gs}$ in the theoretical model. D_g and D_s are vectors of dummies for source countries of goods and services respectively while e_{kt}, u_{kt} and v_{kt} are firm-time unobservables potentially correlated with regressors.[39]

The trade barrier proxies, t^G_{gkt} and t^S_{skt}, are as defined in Section 2 and represent the empirical counterparts of (the log of) the firm-destination-time dimension of τ_{gkt} and τ_{skt}. Formally, we impose that $\ln \tau_{gkt}$ is a linear combination of a country-specific component t^G_g, a firm-time specific component t^G_{kt} and the trade-barrier proxy t^G_{gkt}. t^G_g is a proxy for average trade costs in country g and is absorbed by the D_g country dummy. t^G_{kt} controls for the average trade costs for the particular bundle of goods purchased by firm k and goes into firm-time unobservables. t^G_{gkt} corresponds to the import tariff of the firm-specific bundle in country g in year t. We impose a similar linear form for $\ln \tau_{skt}$.

Turning to the cost of producing intermediate goods c_g, our empirical specifications allow this to be firm-origin-time-specific: c_{gkt}. We impose that (the log of) c_{gkt} can be linearly decomposed into a country-specific component that will be absorbed by the D_g country dummy, and a firm-time specific component that we capture by means our firm-time unobservables. We impose a similar linear form for c_{skt}. We also assume that e_{gspkt} is distributed Gumbel. We finally allow the value of imports of goods and services to be measured with error, under the assumption that such measurement error is iid.

[39] We refrain from using country-time dummies for reasons related to computational power. Even with a dedicated multi-core server, running the first stage (32) with country-time dummies implies estimating a non-linear model with more than 1000 dummy variables that are not possible to partial out over a sample of about 250 million observations. However, we can run the two second stages (33) and (34) with country-time dummies. The results, provided in Table 9 below, are very similar to those obtained with country dummies.

Therefore u_{gspkt} and v_{gspkt} contain such measurement error and are in general different from e_{gspkt}. In terms of inference, we cluster standard errors at the firm-time level in all estimations.[40]

Five things are worth noting. First, the firm-time specific component e_{kt} in (32) can be arbitrarily correlated with the regressors but vanishes when estimating the first stage conditional logit model. Indeed, components that are not choice-specific do not affect estimations of choice-specific coefficients and/or the choice probabilities. Second, firm-time specific components u_{kt} and v_{kt} in (33) and (34) can also be arbitrarily correlated with the regressors and will be accounted for by means of fixed effects. Both types of firm-time components will capture variation over time and unobserved heterogeneity in input prices as well as downstream firms' TFP not accounted for by the model. Third, although the assumptions in Lee (1983) are in general restrictive, they are coherent with our framework. As discussed in Bourguignon et al. (2007), Lee (1983) imposes a certain structure on the correlation between the error terms in the selection and outcome equations. Considering for example the import of goods outcome, the correlations between e_{qrpkt} - e_{gspkt} and u_{gspkt} should be identical for all q and r. This result naturally follows in our framework from the fact that e_{gspkt} and u_{gspkt} are iid across alternatives and differ from each other only by some orthogonal iid measurement error. Fourth, because of the presence of $y_{gspk,t-2}$ and the fact that we allow trade barriers to be firm-time-origin specific, the probability of choosing a particular gs sourcing pair at time t will vary across production lines and time ($s_{gspkt} = s_{gs}$ in the model in Section 3). Yet, it is straightforward to show it is still true that s_{gspkt} will in general be different from the product of marginal probabilities s_{gpkt} and s_{spkt} and will be equal to that product only in the special case of $\theta_{gs} = 1, \forall g, s$.[41] Fifth, in the second stage of the model we estimate equations (33) and (34) by means of a Poisson pseudo-maximum-likelihood (PPML) estimator rather than log-linearizing and using OLS. This reflects our interest in import values, rather than log-values, which is instrumental to our quantification exercise.[42]

[40] It would have been perhaps desirable to cluster standard errors at the country level. However, this is technically not possible when having fixed effects in a regression. Indeed, in order to operate clustering of standard errors in fixed effects models individuals (a firm-time pair in our setting) should be nested within clusters while in our estimations the same firm-year could span into several clusters (countries).

[41] In estimating (32) we employ the Stata command *clogit* and trim some observations based on the distribution of the number of instances y_{gspkt} is equal to one across firm-years. More specifically, we exclude from the estimation those (very few) observations pertaining to firms that in a given year import from more than 100 goods-services origin pairs. We do this because of computational constraints.

[42] The equivalence between a Poisson and a log linear model strictly holds in the case of errors distributed log-normally and homoscedasticity. In such a case Lee (1983) is perfectly consistent with our framework and in particular with estimating second stages in levels rather than log-linearizing.

4.2 Estimation Results

Focusing on column (1) of Table 7, we can observe the first step of our estimation procedure for the complete sample. The exclusion restriction, $y_{gspk,t-2}$, is highly significant, meaning that past import status/fixed costs is a strong predictor of current import status. All the other covariates have the expected sign and significance level. More specifically, goods and services are disproportionately more likely to be sourced from the same country (positive and significant coefficient of θ_{gs}) while trade barriers for both goods and services matter in the choice of a particular gs pair.

In columns (2) and (3) of Table 7, we show the results of the second step of our estimation. The most important result is that there is again evidence of strong complementarities in importing goods and services together, as shown by the positive and significant coefficient of θ_{gs}. In particular, firms import a higher value of goods and services when sourcing from the same country which is at odds with a simple fixed costs savings mechanism. At the same time, goods (services) trade barriers decrease goods (services) import values. Moreover, services trade barriers have a negative and significant effect on the value of goods imports. Similarly, goods trade restrictions have a negative and significant impact on services imports values. Finally, the additional control for selection dictated by the Lee (1983) model and coming from the first step (we loosely label this 'inverse Mills ratio' - IMR - in what follows) is highly significant in both the goods and services values regressions suggesting that it is indeed warranted to control for selection.

In terms of magnitudes there are several things to notice. First, the easiest coefficient to interpret and compare with previous studies is the one of t^G_{gkt} in column (2). That coefficient measures the elasticity of goods trade values with respect to tariffs. A value of -2.44% means that a 1% ad valorem tariff reduces trade values by 2.44%; a number in line with the existing literature on trade elasticities (Broda and Weinstein, 2006). As far as θ_{gs} is concerned, values from columns (2) and (3) indicate that, everything else equal, importing goods and services from the same country corresponds to about 45-50% higher import values. This is by all means sizeable. Moving to t^S_{skt}, there is no clear scale to consider but variation in the data. In this respect, a one standard deviation increase in t^S_{skt} implies a 13% decrease of import values for goods and a 5% decrease of import values for services. The corresponding numbers for t^G_{gkt} are a 5% reduction for goods and a 6% reduction for services. All in all, this suggests there is scope for larger trade boost effects stemming from a reduction in services as compared to goods trade barriers.

Finally, in estimating (33) and (34) we trim the top and bottom 0.5% of observations based on the distribution of Imp^{goods}_{gspkt} and $Imp^{services}_{gspkt}$.

Second, in the model described in Section 3 the parameters corresponding to θ_{gs}, t^G_{gkt} and t^S_{skt} are the same across the selection and outcome equations. The use of a latent model for estimating the selection equation means that the coefficients of our first stage are not comparable to those of the second stage. More specifically, coefficients in column one cannot be translated into meaningful partial effects within the conditional multinomial logit model.[43] Yet, coefficient ratios are comparable. In this respect, looking across coefficients in columns (1) to (3) does suggest that, despite being simple, our model imposes coefficient restrictions that find some counterpart in the data.

In Panel (b) an (c) of Table 7 we decompose the effect on total imports into two margins of adjustment: the number of products or services and the average imports per product or service. In panel (b) we present the results for the imports of goods and in panel (c) those for the imports of services. As is evident from these results, service and goods trade barriers have an effect on both adjustment margins for both goods and services trade. That is, higher tariffs on goods not only reduce the number of products imported and the average imports per product but have a similar effect on the number of service types and the average imports per service. Likewise, services trade barriers reduce both goods and services trade along both adjustment margins.

To explore the data further and provide additional support to our analysis, in panel (a) of Table 8 we restrict our estimations to the sample of firms belonging to the manufacturing sector only. The idea is to check whether results are possibly stronger for such firms who are more likely to combine imported goods and services into a production process along the lines described in equation (7). Results look qualitatively identical to those of the complete sample both for the first step and for the second steps. In terms of magnitudes, however, the coefficients corresponding to trade barriers in the outcomes equations (first step coefficients are not really comparable) are considerably larger when restricting the attention to manufacturing firms which is in line with intuition. On the other hand, the coefficients of θ_{gs} are broadly similar between Table 7 and Table 8 suggesting that the strength of complementarities between goods and service sourced from the same country is roughly comparable for manufacturing and non-manufacturing firms.

In panel (b) of Table 8 we restrict our estimation sample to Belgian multinational and foreign owned firms.[44] On the one hand, these firms have a more prominent involvement in international activities than purely domestic firms and might be the ones benefiting the most from a reduction in trade barriers. On the other hand, they also have extended networks across countries allowing them to minimize the impact of dif-

[43]See Wooldridge (2010) for an in-depth discussion of this point.
[44]It is possible to identify such firms using the NBB Survey on FDI.

Table 7: Main Estimation Results

	Panel (a): Complete Sample			Panel (b): disentangling $\text{Imp}^{Goods}_{gspkt}$		Panel (c): disentangling $\text{Imp}^{Services}_{gspkt}$	
	1^{st} Stage	2^{nd} Stage	2^{nd} Stage	Number of Products	Intensive Margin	Number of Services	Intensive Margin
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dep. Var.	y_{gspkt}	$\text{Imp}^{Goods}_{gspkt}$	$\text{Imp}^{Services}_{gspkt}$				
$y_{gspk,t-2}$	3.3361^a						
	(0.0123)						
θ_{gs}	0.3821^a	0.5119^a	0.4439^a	0.4344^a	0.3778^a	0.2886^a	0.4195^a
	(0.0047)	(0.0172)	(0.0249)	(0.0133)	(0.0248)	(0.0066)	(0.0287)
t^G_{gkt}	-0.0264^a	-0.0244^a	-0.0295^b	-0.0370^a	-0.0245^a	-0.0174^a	-0.0104
	(0.0220)	(0.006)	(0.0173)	(0.0040)	(0.0071)	(0.0057)	(0.0171)
t^S_{skt}	-0.0274^a	-0.1290^a	-0.0421^b	-0.0868^a	-0.0831^b	-0.0203^a	-0.0402^c
	(0.0086)	(0.0296)	(0.0195)	(0.0240)	(0.0370)	(0.0040)	(0.0211)
IMR		0.8606^a	0.9708^a	0.6092^a	0.8302^a	0.5008^a	0.8370^a
		(0.023)	(0.0329)	(0.0154)	(0.0258)	(0.0085)	(0.0344)
D_g	yes	yes	yes	yes	yes	yes	yes
D_s	yes	yes	yes	yes	yes	yes	yes
Firm-year FE	yes	yes	yes	yes	yes	yes	yes
	Cond. Logit	PPML	PPML	PPML	PPML	PPML	PPML
Observations	254,204,600	1,201,131	1,008,274	1,201,131	1,201,131	1,008,274	1,008,274
# of Firm-Years	97,762	69,888	41,297	69,888	69,888	41,297	41,297
(Pseudo) R2	0.45						

Note: Firm-year clustered standard errors in parentheses. ^{a} $p<0.01$, ^{b} $p<0.05$, ^{c} $p<0.1$

ferences in trade costs across origins. Despite the sharp reduction in the number of observations, results in columns (4) to (6) look very similar to those of the complete sample and coefficients are all significant apart from a single case. Magnitudes are also roughly comparable between the complete sample and the multinational and foreign owned sample suggesting that multinational and foreign owned firms are no more or less likely to benefit from a trade liberalization in goods and/or services.[45]

In panel (c) we analyze to what extent potential endogeneity arising from the use of in-sample weights for our trade barrier measures could be affecting our results. Specifically, we now compute firm-level weights using data for the period 1995-2000 and perform the regression for the 2001-2005 period only. Using pre-sample weights in this way should reduce endogeneity concerns although it also more than halves sample size. As seen, the results are very similar to our baseline regression in Table 7. Significance levels are reduced for two of the services trade barrier coefficients but this seems to be mainly due to the strong decrease in the number of observations (coefficient magnitudes are not systematically smaller in absolute terms).

Table 9 reports the results of three additional robustness checks. For comparison, Panel (a) reproduces the estimates from our baseline specification (panel (a) of Table 7). In Panel (b) we run another alternative set of second-stage regressions where we control for country-year fixed effects. (As explained above, using country-year in addition to firm-year fixed effects in the first stage would be computationally infeasible.) In these regressions, we use the inverse Mills ratio from the baseline regression to control for selection effects. Results are qualitatively similar to the baseline, with slightly higher estimated trade cost elasticities.

In panel (c) we check whether controlling for selection is crucial for our results. In particular, we exclude from the estimation of the two outcome equations the inverse Mills ratio computed in the (baseline) first stage. Results remain qualitatively unchanged. However, coefficient values are increased somewhat in absolute terms. Overall, this suggests that controlling for selection is warranted but does not affect our core findings much.

Finally, in panel (d) we use the services trade Restriction Index data developed by the World Bank as an alternative measure of services trade restrictiveness. Results again remain substantially unchanged.[46]

[45] Insofar as multinational firms are more likely to trade within firm boundaries, these results are also suggestive of intra-firm trade patterns of goods and services imports being similar to at-arm's-length trade. Unfortunately, our data is not detailed enough to allow a more direct investigation. This is because the services trade data lump all intra-firm transactions into one aggregate category called "Services between Related Enterprises", and our goods trade data also do not allow us to identify intra-firm transaction separately.

[46] In unreported results, we have also run regressions with origin-pair firm fixed effects in the first

Table 8: Additional Estimation Results and Robustness checks

	Panel (a): Manufacturing			Panel (b): MNE and Foreign Owned			Panel (c): 2001-2005 Sample		
	1^{st} Stage	2^{nd} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	2^{nd} Stage
	(1)	(2)	(3)	(4)	(5)	(6)			
Dep. Var.	y_{gspkt}	$\text{Imp}^{Goods}_{gspkt}$	$\text{Imp}^{Services}_{gspkt}$	y_{gspkt}	$\text{Imp}^{Goods}_{gspkt}$	$\text{Imp}^{Services}_{gspkt}$			
$y_{gspk,t-2}$	3.0806^a			3.0351^a			3.8516^a		
	(0.0210)			(0.0257)			(0.0225)		
θ_{gs}	0.2721^a	0.4440^a	0.4064^a	0.2686^a	0.4875^a	0.4723^a	0.1668^a	0.4803^a	0.5062^a
	(0.0058)	(0.0224)	(0.0276)	(0.0072)	(0.0245)	(0.0367)	(0.0086)	(0.0269)	(0.0415)
t^G_{gkt}	-0.0188^a	-0.0682^a	-0.0963^a	-0.0179^a	-0.0395^a	-0.0441^c	-0.0168^a	-0.0296^b	-0.1238^a
	(0.0032)	(0.0126)	(0.0235)	(0.0034)	(0.0103)	(0.0260)	(0.0035)	(0.0114)	(0.0401)
t^S_{skt}	-0.0580^a	-0.1901^a	-0.2091^a	-0.0418^a	-0.1327^a	-0.0154	-0.0243	-0.0471	-0.0646^b
	(0.0150)	(0.0354)	(0.0395)	(0.0173)	(0.0372)	(0.0286)	(0.0151)	(0.0415)	(0.0320)
IMR		-0.7128^a	-1.0447^a		-0.9457^a	-1.2070^a		0.7769^a	0.8960^a
		(0.0390)	(0.0528)		(0.0403)	(0.0629)		(0.0339)	(0.0535)
D_g	yes	yes	yes	yes	yes	yes	yes	yes	yes
D_s	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm-year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
	Cond. Logit	PPML	PPML	Cond. Logit	PPML	PPML	Cond. Logit	PPML	PPML
Observations	70,998,200	589,863	509,525	36,480,600	619,103	593,209	73,785,400	476,695	419,329
# of Firm-Years	27,307	24,401	13,307	14,031	13,200	10,858	28,379	21,013	13,416
(Pseudo) R2	0.45			0.40			0.49		

Note: Firm-year clustered standard errors in parentheses. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Table 9: Additional Robustness Checks

	Panel (a): Baseline, complete sample			Panel (b): Country-time dummies		Panel (c): No Inv. Mills Ratio		Panel (d): SRI		
	1^{st} Stage	2^{nd} Stage	2^{nd} Stage	2^{nd} Stage	2^{nd} Stage	2^{nd} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	2^{nd} Stage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dep. Var.	y_{gspkt}	$\text{Imp}_{gspkt}^{Goods}$	$\text{Imp}_{gspkt}^{Services}$	$\text{Imp}_{gspkt}^{Goods}$	$\text{Imp}_{gspkt}^{Services}$	$\text{Imp}_{gspkt}^{Goods}$	$\text{Imp}_{gspkt}^{Services}$	y_{gspkt}	$\text{Imp}_{gspkt}^{Goods}$	$\text{Imp}_{gspkt}^{Services}$
$y_{gspk,t-2}$	3.3361^a							3.3344		
	(0.0123)							(0.0123)		
θ_{gs}	0.3821^a	0.5119^a	0.4439^a	0.5088^a	0.4399^a	0.6626^a	0.6385^a	0.3820^a	.5119^a	0.4457^a
	(0.0047)	(0.0172)	(0.0249)	(0.0170)	(0.0247)	(0.0170)	(0.0246)	(0.0046)	(0.0172)	(0.0249)
t_{gkt}^{G}	-0.0264^a	-0.0244^a	-0.0295^a	-0.0273^a	-0.0329^a	-0.0327^a	-0.0438^b	-0.0264^a	-0.0244^a	-0.0293^a
	(0.0220)	(0.006)	(0.0173)	(0.0061)	(0.0163)	(0.0060)	(0.0185)	(0.0022)	(0.0060)	(0.0173)
t_{skt}^{S}	-0.0274^a	-0.1290^a	-0.0421^a	-0.1380^a	-0.0612^a	-0.1500^a	-0.0576^b	-0.6073^a	-1.2406^a	-0.3579^a
	(0.0086)	(0.0296)	(0.0195)	(0.0296)	(0.0197)	(0.0290)	(0.0194)	(0.0467)	(0.1875)	(0.1146)
IMR		0.8606^a	0.9708^a	0.8707^a	0.9770^a				0.8598^a	0.9695^a
		(0.023)	(0.0329)	(0.0222)	(0.0309)				(0.0229)	(0.0331)
D_g	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
D_s	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm-year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country-year dummies	no	no	no	yes	yes	no	no	no	no	no
	Cond. Logit	PPML	PPML	PPML	PPML	PPML	PPML	Cond. Logit	PPML	PPML
Observations	254,204,600	1,201,131	1,008,274	1,201,131	1,008,274	1,201,131	1,008,274	254,204,600	1,201,131	1,008,274
# of Firm-Years	97,762	69,888	41,297	69,888	41,297	69,888	41,297	97,771	69,888	41,297
(Pseudo) R2	0.45							0.45		

Note: Firm-year clustered standard errors in parentheses. ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

5 Quantification

Our empirical model can be used to quantify the impact of changes in trade barriers on both trade in goods and trade in services. In this respect we acknowledge that, due to the above discussed discrepancies between the empirical model laid down in Section 4 and the discrete choice sourcing model presented in Section 3, the results presented below do not correspond to a fully structural counterfactual analysis.

We focus on data referring to the most recent year – 2005 – and hypothesize that the EU and the US sign a trade agreement. We explore the effects of three different scenarios: i) the trade agreement eliminates barriers to trade in goods only (Scenario G); ii) the trade agreement eliminates barriers to trade in services only (scenario S); iii) the trade agreement eliminates barriers to both goods and services (Scenario GS). More precisely, we consider counterfactual scenarios where the US and the EU set zero tariffs on goods (G), implement provisions on trade in services that replicate the services trade agreements in our data, which we used to quantify our parameters (S), or do both (GS).

Our thought experiment thus provides insights into the potential effects of a trade agreement between the United States and the European Union.[47] Our exercise involves the comparison of imports of Belgian firms predicted by our model under the current trade barriers situation versus the situation in which trade barriers between Belgium and the US are set to zero ($t^G_{gkt} = 0$ when $g = US$ and/or $t^S_{skt} = 0$ when $s = US$). This is accomplished in three steps: first we compute for all firms the counterfactual probabilities of importing goods and services from any gs pair under the different scenarios, as described in equation (32); second, we compute counterfactual firm imports from any gs pair using equations (33) and (34). Finally, we consider the product of importing probabilities and imported values at the firm level and aggregate this up to obtain total trade values.

This process is computationally intensive due to the dimensionality of the data but otherwise straightforward. More involved calculations are required to compute counterfactual changes in the product-line price indices (22).[48] Counterfactual price

stage and origin-country-firm fixed effects in the second stage, so that identification relied on time-series variation only. Results were qualitatively similar to our main specification and the coefficients on the tariff variables were if anything larger in magnitude than before. However, given that there is not much variation within firm-origin pair groups, the effective sample size was dramatically reduced (to about 1 per cent of the original first-stage sample).

[47]We fully acknowledge that the TTIP proposal involved more than just goods and services trade. For example, issues related to investments or intellectual property rights were supposed to be covered by the agreement. Our experiment should be seen as only quantifying the consequences of this type of agreement for trade in goods and trade in services, all else equal. Given the current state of international trade relations, the reader might also want to interpret our results as trade increases foregone because of the lack of further integration.

[48]Rather than solving the integral involved in (22) we use estimates from the first stage and draw

index values are needed to correctly scale firm imports from any gs pair coming from (33) and (34) but do not affect first stage probabilities. We find such counterfactual price index changes to be rather small (around -0.1% for all three liberalization scenarios) and so in what follows we ignore them.

Comparing the predicted baseline probabilities of importing and those predicted under the three different scenarios for the US, we observe in Table 10 that the share of importers of services increases by 0.3% in case of trade in goods liberalization (G), by 4.2% in the case of services liberalization (S) and by 4.5% in case of both goods and services liberalization (GS). The increases in the share of firms importing goods from the US are respectively 6.0% (G), 0.1% (S) and 6.1% (GS). Therefore, both trade liberalizations have positive effects on both the share of Belgian goods and services importers from the US.

Table 10: Results of the counterfactual experiments

Scenario	**Changes:**			
	Share of G importers	Share of S importers	Aggregate G imports	Aggregate S imports
Baseline				
G	+6.0%	+0.3%	+16.5%	+2.3%
S	+0.1%	+4.2%	+4.8%	+8.0%
GS	+6.1%	+4.5%	+21.9%	+10.6%
Set $\theta_{gs} = 1, \forall gs$				
G			+16.8%	+0.8%
S			+1.7%	+7.5%
GS			+18.7%	+8.5%

We now turn to the effects on overall import values. Our model does a good job in matching aggregate imports by country. More specifically, our model can replicate 95% of the cross-country variation in goods imports and 87% of the cross-country variation in trade in services. Looking at our three scenarios, we see from Table 10, that goods imports from the US would increase by 16.5% for the goods-only liberalization (G), by about 4.8% for the services trade liberalization (S) and by 21.9% in the case of both (GS). Considering that in 2015 the US exported goods to Belgium for a value of about 34 billion dollars, a 21.9% increase stemming from a joint goods and services liberalization translates into approximately 7.5 billion dollars more trade. Using similar figures for the entire EU the 21.9% figure would imply a 60 billion dollars increase in trade in goods between the US and the EU. Using a similar reasoning a services-only

a 254,204,600 iid random sample from the Gumbel distribution. Using both the parameters and the 254,204,600 $\ln \xi_{gspkt}$ values we then compute the numerical equivalent of (22) while setting $\sigma = 5$ as suggested in Anderson and Van Wincoop (2003). We repeat the process 200 times and assign to P the average value across the 200 replications. This corresponds to the initial value of the price index. In order to compute counterfactual changes of the price index we apply the same procedure while using counterfactual parameter values.

(goods-only) trade liberalization would only bring about 14 (45) billion dollars more trade in goods between the US and the EU. Therefore, the increase in goods imports would be important for both liberalizations, but the highest gains can be achieved only through joint liberalization. Moreover, the effect of joint liberalization is somewhat stronger than the separate effects of the two (i.e. the gains from (G) + (S) are lower than (GS)).

Looking at the services imports side in the last column of Table 10, the increases would respectively be of 2.3% (G), 8.0% (S) and 10.6% (GS). Considering that in 2014 the US exported services to the EU for a value of about 220 billion dollars, an 11% increase translates into 24 billion dollars more trade. As for goods, both liberalizations affect trade in services, but the joint effect of (GS) is slightly stronger than the sum of the two (G+S). Our numbers are qualitatively similar to those computed for other European countries and with different methodologies. For example, Felbermayr and Larch (2013) study the potential impact of TTIP on some EU countries' imports and exports. Their study predicts an increase in US exports to Germany in the order of 18% for goods and 1.4% for services.[49]

In our analysis we model complementarities between imports of goods and services at the firm level via two channels: (i) a technological parameter Θ_{gs} taking a value greater than unity when goods and services are imported from the same country; (ii) the joint use of goods and services in firms' production functions implying that service (goods) trade barriers impact the sourcing choice and value of goods (services) imports. In order to gauge which effect dominates quantitatively in our analysis we perform the following exercise. We first eliminate the effects arising from Θ_{gs}. In terms of our econometric specification, this is done by setting the dummy variable θ_{gs} in equations (32)-(34) to zero for *all* g and s. We then recompute import probabilities, import values and aggregate imports by country. Finally, we perform our 3 counterfactual trade liberalization scenarios under the $\theta_{gs} = 0$ constraint. In doing so we find the increase in trade in goods with the US to be 16.8% (G), 1.7% (S) and 18.7% (GS). With respect to services imports, we predict increases of 0.8% (G), 7.5% (S) and 8.5% (GS). These numbers are overall smaller than with an unconstrained θ, but suggest that channel (ii) is relatively more important.

Lastly, we note that our model also features third-country effects. Trade barriers with the US affect Belgian firms' importing probabilities, import values and therefore total imports from *all* countries. As shown in online appendix Table 6, however, aggregate

[49]Their liberalisation scenario for goods trade is identical to ours (elimination of tariff barriers but no reductions of non-tariff barriers) while the assumed services trade liberalisation scenario is less far-reaching and not directly comparable to ours (see p.58 in their paper for details). This might explain the smaller estimated effect on services trade in their study.

country-level import changes are quantitatively small, mostly below 1%. Qualitatively, the changes follow clear patterns. Consider first a reduction in goods trade barriers only. It has a negative impact on Belgian imports of from third countries, because the now cheaper US goods are substitutes with respect to goods imported from other countries. However, our Cobb-Douglas production function (7) implies that services imports from third countries are positively affected, because the now cheaper US goods are complements of services imports from all countries (more so of US services imports services, due to the parameter Θ). When we consider a reduction in services trade barriers with the US only, mirror-image patterns apply. Now consider a joint reduction of goods and services trade barriers with the US. We find that complementary effects dominate substitution effects: trade in both goods and services with third countries increase in all but a few instances (trade in goods with Liberia, Slovakia and Turkey as well as trade in services with Taiwan). In terms of most affected countries, substitution effects tend to be stronger for some of the major EU partners of Belgium (France, UK, Poland) as well as for Turkey, Israel and Brazil. As for complementarity effects, a much stronger geographical pattern emerges in which EU partners enjoy the largest increases in trade (especially Luxembourg, Italy, Germany and Spain).[50]

6 Conclusions

In this paper we examine the interactions between goods and services imports within firms and explore the implications for goods and services trade policies. We start from several observations pointing towards some complementarity between imports of both types of products. Firstly, sourcing both goods and services from the same country is disproportionately likely, given the marginal frequencies of importing goods or importing services from that country. Secondly, importers of both goods and services account for the lion's share of Belgian imports and joint sourcing is associated with higher productivity. Thirdly, services imports appear to be negatively correlated with goods trade barriers and vice versa, even when controlling for firm-year and country unobservables.

We then develop a theoretical model to guide our empirical analysis that embeds a discrete choice of input origin countries in a simple general equilibrium setup. The model ties the choice of origin countries and the conditional choice of import values to a relatively narrow set of parameters. In particular, we capture technological complemen-

[50] In our theoretical framework, the counterfactual changes in trade barriers affect Belgian and other non-US suppliers in the same way. In the data, however, we do not have information on domestic input sourcing and hence cannot observe a large part of the demand for domestic inputs (that by Belgian firms from other Belgian firms). As a consequence, we exclude Belgium from our third-country effects in online appendix Table 6.

tarities in goods and services from the same origin country. Moreover, goods-services linkages in our model create a trade policy spillover, not just from intermediate to final products, but also from intermediate goods to intermediate services.

In moving to the empirics, we go beyond the model to better capture the richness of the data and to consider complementary channels. In particular, we use the selection model developed in Lee (1983) and described by Bourguignon et al. (2007). The first-stage selection equation features a conditional multinomial logit for the probability to source inputs from a given country. In the second stage, we estimate two export value outcome regressions, one for goods and one for services, that are augmented with selection-bias controls coming from the first stage. We also allow for both firm-specific time-varying and country-specific time invariant unobservables that may be arbitrarily correlated with the regressors in both the first and second stage.

Our estimation allows us to compute counterfactual responses to changes in trade barriers and to quantify goods-services spillovers. Our results are important not just because bi-traders account for a large share of trade, but also because they can affect the design of trade policy evaluation and of trade policy itself.

By focusing on firms rather than sectors, this paper offers a first attempt at looking at goods-services trade policy spillovers while accounting for the ongoing "servitization" of manufacturing. Several simplifying assumptions were necessary to achieve tractability and we look forward to further work extending our approach.

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